

## CLAIMS

1. A method for analyzing a copper electroplating solution containing an additive, which comprises determining the time-dependent potential change at a cathode current density of  $0.1 - 20 \text{ A/dm}^2$  to thereby judge the fillability with the copper electroplating solution.

2. The method for analyzing a copper electroplating solution as claimed in claim 1, wherein the time-dependent potential change determination is effected while the rotation of the working electrode is controlled in the range of 100 - 7500 rpm.

3. The method for analyzing a copper electroplating solution as claimed in claim 1, wherein the fillability is judged by obtaining the potential change speed in the initial stage of electrolysis and the potential convergent point from the time-dependent potential change curve for a predetermined period of time after the start of the electrolysis.

4. The method for analyzing a copper electroplating solution as claimed in claim 1, wherein the fillability is judged by approximating the time-dependent potential change curve for a predetermined period of time after the start of the electrolysis, according to the Boltzmann's function represented by the following numerical formula (1), to thereby obtain the potential change speed  $dx$ :

$$y = \frac{A_1 - A_2}{1 + e^{\frac{x-x_0}{dx}}} + A_2 \quad \dots (1).$$

5. An apparatus for analyzing a copper electroplating solution, which comprises using the method for analyzing a copper electroplating solution of claim 1.

6. A method for fabricating a semiconductor product, which comprises using the method for analyzing a copper electroplating solution of claim 1 and controlling the condition of the solution so as to make the time-dependent change curve profile of the solution near to that of the original solution when it is judged that the condition of the solution is not good and satisfactory fillability could not be obtained.

7. A method for analyzing a copper electroplating solution used in copper electroplating for filling a copper metal in a via-hole or a trench installed in a semiconductor product, which comprises using an electrochemical cell composed of a working electrode (rotary electrode), a reference electrode and a copper electrode (counter electrode) for a copper electroplating solution, electrolyzing the solution with the working electrode (rotary electrode) as a cathode so as to make the cathode current density controlled in the range of 0.1 - 20 A/dm<sup>2</sup>, determining the time-dependent potential change between the cathode and the reference electrode for a predetermined period of time after the start of the electrolysis,

and judging the fillability with the copper electroplating solution from the time-dependent change curve profile.

8. The method for analyzing a copper electroplating solution as claimed in claim 7, wherein the time-dependent potential change determination is effected while the rotation of the working electrode is controlled in the range of 100 - 7500 rpm.

9. The method for analyzing a copper electroplating solution as claimed in claim 7, wherein the fillability is judged by obtaining the potential change speed in the initial stage of electrolysis and the potential convergent point from the time-dependent potential change curve for a predetermined period of time after the start of the electrolysis.

10. The method for analyzing a copper electroplating solution as claimed in claim 7, wherein the fillability is judged by approximating the time-dependent potential change curve for a predetermined period of time after the start of the electrolysis, according to the Boltzmann's function represented by the following numerical formula (1), to thereby obtain the potential change speed  $dx$  in the initial stage and the potential convergent point  $A_2$ :

$$y = \frac{A_1 - A_2}{1 + e^{\frac{x - x_0}{dx}}} + A_2 \quad \dots (1).$$

11. An apparatus for analyzing a copper electroplating

solution, which comprises using the method for analyzing a copper electroplating solution of claim 7.

12. A method for fabricating a semiconductor product, which comprises using the method for analyzing a copper electroplating solution of claim 7 and controlling the condition of the solution so as to make the time-dependent change curve profile of the solution near to that of the original solution when it is judged that the condition of the solution is not good and satisfactory fillability could not be obtained.

13. A method for analyzing a copper electroplating solution containing an additive, which comprises using an electrochemical cell composed of a working electrode (rotary electrode), a reference electrode and a copper electrode (counter electrode) for a copper electroplating solution, electrolyzing the solution with the working electrode (rotary electrode) as a cathode so as to make the cathode current density controlled in the range of  $0.1 - 20 \text{ A/dm}^2$ , and determining the time-dependent potential change for a predetermined period of time after the start of the electrolysis to thereby judge the uniformity of electrodeposition (film properties and film thickness uniformity) with the solution.

14. The method for analyzing a copper electroplating solution as claimed in claim 13, wherein the time-dependent potential change determination is effected while the rotation of the working electrode (rotary electrode) is controlled in

the range of 100 - 7500 rpm.

15. The method for analyzing a copper electroplating solution as claimed in claim 13, wherein the fillability is judged obtaining the potential change speed in the initial stage of electrolysis and the potential convergent point from the time-dependent potential change curve for a predetermined period of time after the start of the electrolysis.

16. The method for analyzing a copper electroplating solution as claimed in claim 13, wherein the uniformity of electrodeposition (film properties and film thickness uniformity) is quantitatively judged by approximating the time-dependent potential change curve according to the Boltzmann's function represented by the following numerical formula (1) to thereby obtain the potential change speed  $dx$ :

$$y = \frac{A_1 - A_2}{1 + e^{\frac{x-x_0}{dx}}} + A_2 \quad \dots (1).$$

17. An apparatus for analyzing a copper electroplating solution, which comprises using the method for analyzing a copper electroplating solution of claim 13.

18. A method for fabricating a semiconductor product, which comprises using the method for analyzing a copper electroplating solution of claim 13 and controlling the condition of the solution so as to make the time-dependent change curve profile of the solution near to that of the original solution

when it is judged that the condition of the solution is not good and satisfactory fillability could not be obtained.

19. A method for analyzing a copper electroplating solution used in copper electroplating for filling a copper metal in a via-hole or a trench installed in a semiconductor product, which comprises using an electrochemical cell composed of a working electrode (rotary electrode), a reference electrode and a copper electrode (counter electrode) for a copper electroplating solution, electrolyzing the solution with the working electrode (rotary electrode) as a cathode so as to make the cathode current density controlled in the range of 0.1 - 20 A/dm<sup>2</sup>, controlling the rotation of the working electrode (rotary electrode) in two stages falling within a range of 0 - 7500 rpm, determining the time-dependent potential change between the cathode and the reference electrode at different rotations, and comparing the time-dependent change curves with each other to thereby judge the fillability with the copper electroplating solution.

20. An apparatus for analyzing a copper electroplating solution, which comprises using the method for analyzing a copper electroplating solution of claim 19.

21. A method for fabricating a semiconductor product, which comprises using the method for analyzing a copper electroplating solution of claim 19 and controlling the condition of the solution so as to make the time-dependent change curve

profile of the solution near to that of the original solution when it is judged that the condition of the solution is not good and satisfactory fillability could not be obtained.